2020 Sec 4 Advanced Physics Exercise 2

Electromagnetism: Electric and Magnetic Fields

Name: _____ (   )   Class: 4/ ____   Date: _____

Given formulae and constant:

$$E = \frac{F}{q} \qquad F = \left| \frac{kQq}{r^2} \right| \qquad F = BIL \qquad F = Bqv$$

where $k = 8.99 \times 10^9$ kg m^3 s^{-4} A^{-2}

$$v = r\,\omega \qquad\qquad a = \frac{v^2}{r}$$

For relevant calculations, you may take the mass of a proton to be 1.67×10^{-27} kg and its charge to be 1.60×10^{-19} C.

1   Two identical point charges were initially separated by a distance of d. Due to the mutual repulsion, they move away from each other. When the separation increased by 5.0 mm, the repulsion force decreased from 100 μN to 25 μN.

(a)   Calculate the value of d.
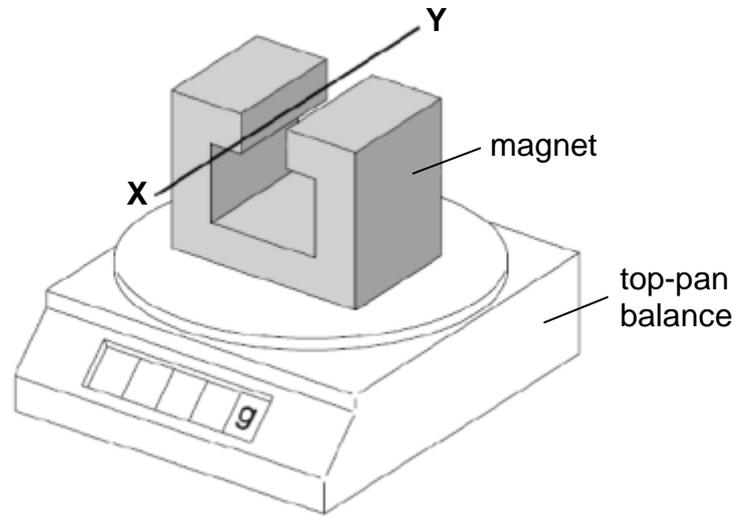
d = …………………………….

(b)   Determine the magnitude of the charges.

magnitude of charges = …………………………….

2   A horseshoe magnet rest on a top-pan balance with a wire situated between the poles of the magnet. When no current flows in the wire, the reading on the balance is 142.0 g. When a current of 2.0 A flows in the wire in the direction XY, the reading on the balance changes to 144.6 g.


What is the reading on the balance when there is a current of 3.0 A in the wire in the direction YX?

reading on the balance = ...

3   A proton traveling along the x-axis is slowed down by an uniform electric field E. At x = 30 cm, the proton has a speed of 2.5×10^6 m s^{-1} and at x = 60 cm, its speed is zero. Find the magnitude and direction of E.

E = ...

4   A beam of protons are projected with an initial speed of $v_i = 9.55 \times 10^3$ m s^{-1} into a region of uniform electric field $E = 720$ N C^{-1} directed vertically downwards. The protons are to hit a target that lies at a horizontal distance of 1.27 mm away from the point where the protons cross the plane and enter the electric field.
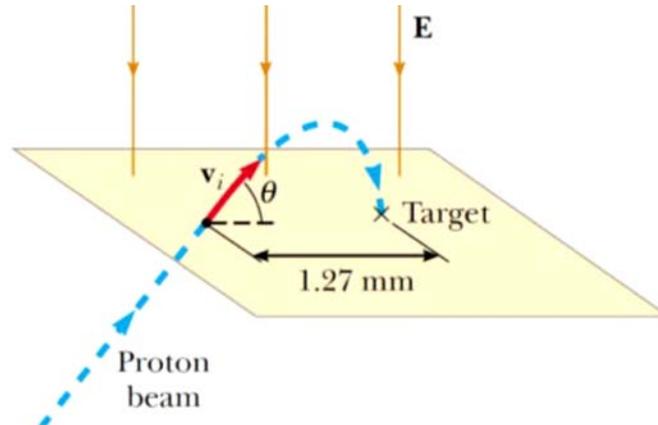
(a)   Determine the two possible angles θ_1 and θ_2 that will result in a successful hit. Ignore gravitational acceleration.

$$\theta_1 = \text{................................}$$

$$\theta_2 = \text{................................}$$

(b)   Determine the time interval during which the proton is above the plane and within the region of the electric field for each trajectory.

$$t_1 = \text{................................}$$

$$t_2 = \text{................................}$$

5 A proton, travelling in a vacuum at a speed of 4.5×10^6 m s^{-1}, enters a region of uniform magnetic field of flux density 0.12 T. The path of the proton in the field is a circular arc, as illustrated in the figure below.

path of proton

region of uniform magnetic field
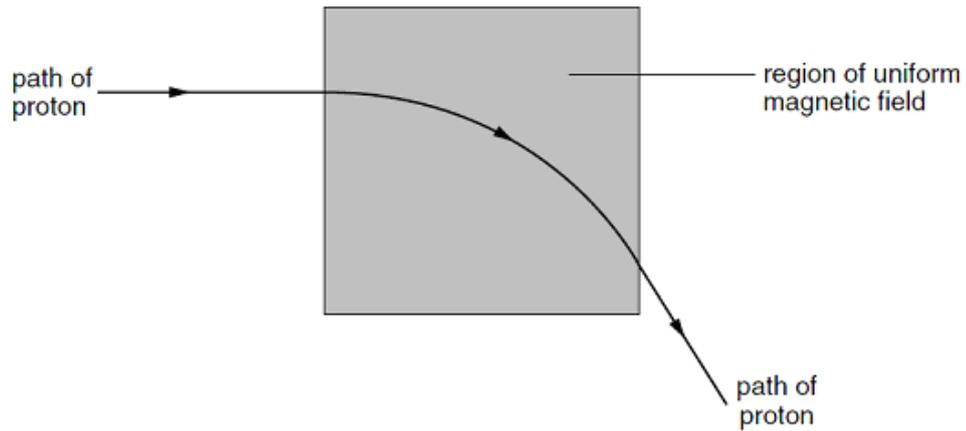
path of proton

(a) State the direction of the magnetic field.

....

(b) Calculate the radius of the path of the proton in the magnetic field.

radius = ...

(c) A uniform electric field is now applied in the same region as the magnetic field, so that the proton passes undeviated through the region.

(i) On the figure above, mark with an arrow labelled E, the direction of the electric field.

(ii) Calculate the magnitude of the electric field strength.

E = ...

Answers:	1(a). 5.0 mm	1(b). 5.3×10^{-10} C	2. 138.1 g	3. -1.09×10^5 N C^{-1}
	4(a). 36.9° / 53.1°	4(b). 166 ns / 221 ns	5(a). out of the page	
	5(b). 0.39 m	5(c)(i). upwards	5(c)(ii). 5.4×10^5 N C^{-1}	